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The introduction of rubber planting recommendations by The Rubber Research Institute of Malaysia since 1925

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Abstract
The establishment of The Rubber Research of Malaysia (RRIM) in 1925 has started the research and development in various aspects related to rubber improvement in Malaysia. Many improvement programmes have been carried out to develop high yielding rubber clones and favourable characters such as low disease incident and wind resistance clones. For almost 90 years, RRIM has introduced the rubber planting recommendations to benefit rubber growers, plantations and smallholdings with the latest observations, evaluations and results obtained from the experimental trials. Rubber planting recommendations produced by RRIM has become the main reference for rubber growers over the years to gather the latest information of high yielding clones that available in Malaysia. There are continuously updated information related to rubber clones presented in the planting recommendations but prior to 1957 there are not much information disseminated through RRIM's internal reports and articles. Therefore, this review summarize the overview of RRIM rubber planting recommendations since 1925 and its impacts to the rubber growers in Malaysia.
Keywords: RRIM, clones, planting recommendations

1.0 The introduction of rubber in Malaysia

Rubber tree (*Hevea brasiliensis*) produces latex by its specialized secretory system in latex vessels that distributed throughout the bark surfaces. Hence, latex is harvested through exercise of injuring the bark surfaces by creating minor cut of the bark layers (Yoonram *et al*., 2008; Shamsul Bahri *et al*., 2013). The characteristics of rubber are highly water resistant, electrically non-conductive and durable in most of its products due to unique molecular structure (Wititsuwannakul *et al*., 2008). In 1876, Henry Wickham from United Kingdom collected about 2000 seedlings from Amazon and dispatched to Sri Lanka (Ceylon). However, only 22 rubber seedlings survived and shipped to Singapore Botanical Garden, Singapore. Later, nine rubber seedlings landed in Malaysia (Malaya) in 1877 and were multiplied and planted in experimental trials between 1890-1914 by Ridley (Webster and Baulkwill, 1989). Since then, the development of commercial rubber planting was expanding rapidly in Malaysia mainly based on the planting materials derived from the nine seedling originated from the Wickham's collection (Webster and Baulkwill, 1989; Malaysian Rubber Board, 2005; Ong and Shamsul Bahri, 2014).

2.0 The era before the introduction of rubber planting recommendations

Rubber planting materials in Malaysia were introduced at several British settlements such as Soengei Pantjoer Experimental Garden, Algemeene Vereniging Rubber Planters Oostkust Sumatra Experiment Station (A.V.R.O.S) and West-Jawa Rubber Experiment Station. In 1919, Maas evaluated the rubber trees that planted in the experimental trials into 20 different classes according to the daily latex production. Maas also started the very first rubber seed garden for RRIM and applied new vegetative propagation techniques in crop improvement purposes. In 1922, Grantham conveyed the technique to plant rubber tree according to different soil types. Dry rubber yield were recorded on the rubber trees that planted at four different soil type *viz.* red soil, white sandy soil loam, white cementing soil and brown loam. Grantham concluded the highest yield would come from the trees planted on red soil that full of high-density root system. Heusser (1924) defined that good rubber tree must be selected from those generated high dry rubber yield followed by disease resistance and physiological factors such as rooting system, branching habits and wind resistance. Bobilioff (1919), Vischer (1921), La Rue (1921) and Heusser (1924) stated that latex vessel is one of the important characteristic in *Hevea* selection. Later, Gunnery (1935) demonstrated the distinctive types of sieves-tubes existed in the main stem and branching system and found a strong correlation between the existence of sieve-tube and dry rubber yield.

Cramer (1924) pointed out the girth growth was crucial in rubber production, as rubber trees grew faster, they would reach at the right circumference for tapping. Cramer also reported that budded trees that multiplied by vegetative propagation technique such as budded No.3 Ct, No.9 Ct and No.88 Ct performed more vigorous compared to seedlings trees. Vries and Spoon (1927) highlighted the vigorous performance of these budded trees along with AV 52 and AV 80. Holder and Heusser (1928) tested A.V.R.O.S. materials such as pedigree number 51, 89, 71, 76, 152, 163 and 174 then concluded that selected seedlings would generate higher latex yield compared to unselected seedlings. Heusser (1932) proceeded with the testing of various legitimate seedling crosses where standard tapping was commenced at the girth circumference of 20 inches (50.8 cm) and at 20 inches (50.8 cm) from ground level, opened for tapping from left-to-right spiral cut half the circumference, on a slope of 22 degrees.

In 1930s, Mann emphasized the comparison of yield between seedlings obtained from hand pollination programmes and unselected seedlings (Mann, 1935; Mann 1937). Tapping was commenced at the girth circumference of 16 inch (40.64 cm) and at 40 inch (101.60 cm) from ground level. There were several outstanding pedigree materials derived from the hand pollination programmes such A.V.R.O.S. 33, 36, 49, 50, 80 and 157. In general, the emphasis on the comparison of "seedling vs budded tree" and no proper grouping of the planting materials before the introduction of rubber planting recommendations. The concept of uniformity using budded trees and pedigree selections was started to gain the attention of rubber growers when they realized that budded trees always achieved higher dry rubber yield compared to unselected seedlings.

3.0 The introduction of rubber planting recommendations

3.1 Rubber planting recommendations from 1957-1974

The data presented in the rubber planting recommendations mainly are from the experimental sites at RRIM. Generally, the latex yield of rubber clones were observed for 10-15 years after planting with at least three replicates arranged in a randomized complete block design under scheduled manuring programmes. The earliest record of Rubber Planting Recommendations was available in 1957 where the introduction of high rubber yielding clones that tested in RRIM breeding programmes. The main characteristics taken into consideration were mainly on vigour of girth growth and low leaf disease incident. Planting recommendations in 1957 introduced Class I rubber clones such as PB 86, Tjirandji 1, RRIM 501, RRIM 513 and GI 1, where Class I clones were considered as high yielding clones that could perform well in large-scaled planting throughout in Malaysia. The clones that were newly tested without proven records were grouped into Class II and Class III. The introduction of new clones such as GT 1 into Class II for moderate planting scale and RRIM 600 Clone Series into Class III for small planting scale that not more than 12 acres in aggregate (RRIM, 1957).

In 1967, RRIM 600 and other RRIM 600 Series clones emerged as the most accepted Class I clone while RRIM 500 Clone Series was slowly been withdrawn from the Planting Recommendations 1967-68 (RRIM, 1967). Meanwhile, Green Bud-Grafting technique was widely implemented to produce rubber planting clones at many plantations (Webster and Baulkwill, 1989). This technique became a popular method to reproduce and multiply clonal materials for experimental testing in RRIM (RRIM, 1957). However, seedlings from Prang Besar Isolated Gardens (PBIG) with proven records were introduced in Planting Recommendations from 1957 to 1974 (RRIM, 1957; RRIM, 1959; RRIM, 1973).

3.2 Environmax planting recommendations from 1975-1979

The concept of Environmax was featured in Planting Recommendations 1967-68 but remained vague until the introduction of Environmax Planting Recommendations 1975. At that time, many rubber clones in RRIM 800 clone series were not recommended to be planted widely in diffrent regions in Malaysia because these clones would not performed well if out of their specific planting regions. The approach was intended to signify the concept of "maximizing the yield potential of a particular locality subject to the inhibitory influence of the environmental factors" as coined in Environmax Planting Recommendations 1975-76 (RRIM, 1975; RRIM 1977). There was an evidence of inbreeding depression in RRIM 800 clone series due to the reproduction of closely related parents (RRIM, 1989). The attentions to disease resistance, growth vigour, fitness after tapping and high rubber yield in taken into serious consideration in Environmanx Planting Recommendations (RRIM 1975; RRIM 1979). Eventually, many clones introduced in Environmax Planting Recommendations only recommended for small-scaled planting where each clone not recommended planting area more than 10 hectares in aggregate. In addition, Crown Budding technique to modify the canopy structure was introduced especially for Class II and III clones. It was recommended to reduce the severe damage caused by robust wind and leaf fall diseases (RRIM 1977).

3.3 RRIM planting recommendations from 1980-1997

RRIM Planting Recommendations were introduced between 1980 and 1997 to replace The Enviromax Planting Recommendations. Maps of major diseases incidents, soil categorization and severe wind damage areas were inserted in RRIM Planting Recommendations started in 1980 (RRIM 1980; RRIM 1983; RRIM 1986). In these RRIM Planting Recommendations, there were three general classes of planting materials that grouped into Class I, Class II and Class III (Class III A and III B). Outstanding Class I Clones were highly recommended for large-scaled planting throughout Malaysia such as RRIM 600, RRIM 712, GT 1, PB 217, PB 260, PR 255 and PR 261. These clones were recommended continuously as common clones planted in Malaysia and good acceptance from the rubber growers between 1980 and 1994 (RRIM, 1994). The major improvement in RRIM Planting Recommendations was the introduction of exceptional rootstocks such as PB 5/51, PB 235, GT 1, RRIM 605 and RRIM 623 in various vegetative budding techniques (RRIM, 1992).

In RRIM Planting Recommendations 1995, there were only two classes of clones compared to three classes in previous recommendations. Rubber growers, plantations and smallholdings could choose to adopt the recommended Class I Clones for large-scaled planting at any region or Class II clones for small-scaled planting at specific regions in Malaysia (RRIM, 1995). The rubber planting materials recommended since 1995 onwards would come with well-tested yield performance records and favourable secondary characteristics such as resistance to bark dryness, resistance to diseases, high girth increment over the years and fast renewed bark. The prominent Class I Clones were as follow: RRIM 600, RRIM 712, RRIM 901, RRIM 908, RRIM 911, RRIM 921, RRIM 936, RRIM 937, RRIM 938, RRIM 940, PB 235, PB 255, PB 260, PB 280, PB 350, PB 355, PB 359 and PB 366. However, Class II Clones such as RRIM 928 and RRIM 929 were not recommended for large-scaled planting because these clones with very limited yield, growth and good secondary characteristics records (MRB, 1998).

3.4 MRB planting recommendations from 1998-2006 onward

RRIM planting recommendations has changed its name to Malaysian Rubber Board (MRB) planting recommendations after the merging of several agencies into RRIM and formed Malaysian Rubber Board in 1998. MRB introduced Latex Timber Clones (LTC) that generate both high latex and rubberwood yield are highlighted and recommended to the rubber growers especially RRIM 2000 Clone Series (Masahuling *et.al.*, 2006; Shigematsu, 2010). RRIM 2000 Clone Series consisted of rubber clones that are well- tested and proven records of latex and rubberwood yield at RRIM's experimental sites. These rubber clones would generate high wood volume through their branching habits along with the outstanding latex yield with over 2000 kg/ha/year as projected in Table 1.

Clone	Branching Habit	Mean Latex Yield (kg/ha/year)
RRIM 2001	Narrow and conical canopy, light green foliage colour. Clustered and widely separated branching. Dissolved in main branch. Smooth bark surface.	2850
RRIM 2002	Dense crown, low and moderate set crown. Acute angle and dissolve in main branch. Vigorous main branchlets and secondary branchlets.	2348
RRIM 2008	Dense and wide canopy but considered as low set crown. Dissolved leader, acute angle and vigorous branching. Possessed smooth bark surface.	2686
RRIM 2009	The branching leader may embraced either persistent or dissolved. Many branchlets on main and secondary branching. Smooth bark surface.	2277
RRIM 2016	High to moderate set canopy. Closed and slightly balanced crown. Persistent main leader with heavy secondary branch leaders. Smooth to slightly bumpy bark surface.	2582
RRIM 2020	Dense and high set crown. Open and balanced canopy. Persistent main leader but with moderate branchlets on main and secondary branching. Colour of latex appeared to be cream in colour.	2232

Table 1. The branching habits and mean latex yield of selected rubber clones from RRIM 2000 Clone Series.

Source: MRB Planting Recommendations 2003.

Table 2. The introduction of planting recommendations by RRIM/MRB since 1925.

Year	Recommendations
1925-1956	Unselected seedlings and vague planting materials
1957	Planting Recommendations 1957
1959	Planting Recommendations 1959-60
1961	Planting Recommendations 1961-62
1963	Planting Recommendations 1963-64
1965	Planting Recommendations 1965-66
1967	Planting Recommendations 1967-68
1969	Planting Recommendations 1969-70
1971	Planting Recommendations 1971-72
1973	Planting Recommendations 1973-74
1975	Environmax Planting Recommendations 1975-76
1977	Environmax Planting Recommendations 1977-79
1980	RRIM Planting Recommendations 1980-82
1983	RRIM Planting Recommendations 1983-85
1986	RRIM Planting Recommendations 1986-88
1989	RRIM Planting Recommendations 1989-91
1992	RRIM Planting Recommendations 1992-94
1995	RRIM Planting Recommendations 1995-97
1998	MRB Planting Recommendations 1998-2000
2003	MRB Planting Recommendations 2003
2006	MRB Planting Recommendations 2006

4.0 Planting Recommendations and its impacts

The Rubber Research Institute of Malaysia is constantly providing new improvements particularly in breeding and selection of rubber clones to the rubber industry over the years as highlighted in Table 2. Overall, the most common clones planted in Malaysia was RRIM 600 from 1970s to 80s and other widely planted clones such as RRIM 605, RRIM 623, GT 1, PR 107, PR 251, PR 261, PB 235 and PB 28/59 (RRIM, 1975; RRIM, 1978). Besides that, RRIM 901 and PB 260 emerged as the most popular clone accepted in Malaysia in 1980s and 90s throughout every region in Malaysia (MRB; 1998). The introduction of RRIM 2000 Clone Series where RRIM 2001 and RRIM 2002 are commonly accepted as high yielding latex timber clone (LTC) while PB 260 remained as the most popular rubber clone meant for latex but not rubberwood yield. Therefore, the classical approach of rubber planting concentrate only for latex yield is gradually phasing out with the introduction of LTC.

Nowadays, Leaf Fall Diseases (LFD), tapping panel dryness (TPD) and branching habits of rubber clones must be fully tested before recommended in rubber planting recommendations. In general, rubber clones that introduced in MRB Planting Recommendations 2003 would have shorter immature period and very vigorous growth in girth increment, which managed to increase profitability through reduction of unproductive period from seven to four years when compared to the clones introduced during 1980s and 90s. Rubber planting recommendations clearly assist the rubber growers to endure the changing circumstances in rubber marketing and supplying, with increasing concern for faster returns to their investments. Furthermore, the development and introduction of rubber clones from RRIM are released for free use to every rubber growers in Malaysia since 1925. In other words, RRIM with its planting recommendations has contributed meaningfully towards the imminent strategies related to the advancements in *Hevea* improvement.

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References

Bobilioff (1919) Investigations concerning the origin of latex vessels and latex in *Hevea brasiliensis*. *Archief Voor De Rubbercultuur*. Rubber Research Institute of Malaya. Vol 3, pp.66-67.

Cramer P.J.S (1924) Our inoculated *Hevea*-trees in their first test year; their growth and production. *Archief Voor De Rubbercultuur*. Rubber Research Institute of Malaya. Vol 8, pp.458-493.

Gunnery H (1935) Yield prediction in *Hevea*. *Journal of the Rubber Research Institute of Malaya*. Vol 6 (1) pp.8-20.

Grantham J (1922) Cultivation experiment in mature rubber. *Archief Voor De Rubbercultuur*. Rubber Research Institute of Malaya. Vol 6, pp.1-31.

Heusser C (1924) Experimental tapping on Hevea-buddings. *Archief Voor De Rubbercultuur*. Rubber Research Institute of Malaya. Vol 40, pp. 69-70.

Heusser C (1932) Yields figures from legitimate *Hevea* seedlings in 1930 in the Soengei Pantjoer Experimental Station. *Archief Voor De Rubbercultuur*. Rubber Research Institute of Malaya. Vol 16, pp.129-156.

Holder H.J.V.S and Heusser C (1928) Experimental tapping on hevea buddings and seedlings on Boekit Maradja Estatae. *Archief Voor De Rubbercultuur*. Rubber Research Institute of Malaya. Vol 12, No.58, pp. 37-49.

La Rue C.D (1921) Correlation in structure between mother and daughter treesof Hevea. *Archief Voor De Rubbercultuur*. Rubber Research Institute of Malaya. Vol 5, pp.43-45.

Maas J.G.J.A (1919) The vegetative propagation of *Hevea Brasiliensis*. *Archief Voor De Rubbercultuur*. Rubber Research Institute of Malaya. Vol 3, pp.279-287.

Malaysian Rubber Board (1998) LGM Planting Recommendations 1998-2000. URL: http://rios. lgm. gov. my / cms. Accessed on 5th July 2011.

Malaysian Rubber Board (2003) LGM Planting Recommendations 2003. URL: http://rios. lgm. gov. my / cms. Accessed on 5th July 2011.

Malaysian Rubber Board (2005) *The evolution of the rubber industry in Malaysia: Navigating and re-inventing the industry*. Malaysian Rubber Board, Kuala Lumpur.

Mann C.E.T (1935) Recent progress in the selection of planting material of *Hevea*. *Journal of the Rubber Research Institute of Malaya*. Vol 6 (1) pp.21-34.

Mann C.E.T (1937) Tapping on budded trees. *Journal of the Rubber Research Institute of Malaya*. Vol 8(1) pp.5-23.

Masahuling Benong, Ramli Othman and Ong Chin Wei (2006) LGM Planting Recommendations 2006. Rubber Planters' Conference 2007, Kuala Lumpur.

Ong Chin Wei and Shamsul Bahri A.R. (2014) The selection for high rubberwood yielding genotypes in 1995

Hevea germplasm, Rantau Panjang Forest Reserve. *Journal of Biology, Agriculture and Healthcare*. Vol. 4, No. 7. Pg. 132-135.
RRIM (1952) Seed Gardens for estates. Planters' Bulletin of The Rubber Research Institute of Malaya. pp.14-21.
RRIM (1957) Planting Recommendations 1957-58. URL: http://rios. lgm. gov.my/cms. Accessed on 5th July 2011.
RRIM (1959) Planting Recommendations 1959-60. URL: http://rios. lgm. gov.my/cms. Accessed on 5th July 2011.
RRIM (1967) Planting Recommendations 1967-68. URL: http://rios. lgm. gov.my/cms. Accessed on 5th July 2011.
RRIM (1973) Planting Recommendations 1973-74. URL: http://rios. lgm. gov.my/cms. Accessed on 5th July 2011.
RRIM (1975) Environmax Planting Recommendations 1975-76. URL: http://rios. lgm.gov.my/cms. Accessed on 5th July 2011.
RRIM (1977) Environmax Planting Recommendations 1977-79. URL: http://rios.lgm.gov.my/cms. Accessed on 5th July 2011.
RRIM (1978) Planting materials used in Peninsular Malaysia, 1975. Planters' Bulletin of The Rubber Research Institute of Malaysia. pp.15-20.
RRIM (1979) Disease survey and planting recommendations. Planters' Bulletin of The Rubber Research Institute of Malaysia. pp.6-10.
RRIM (1980) RRIM Planting Recommendations 1980-82. URL: http://rios. lgm.gov.my/cms. Accessed on 5th July 2011.
RRIM (1983) RRIM Planting Recommendations 1983-85. URL: http://rios. lgm.gov.my cms. Accessed on 5th July 2011.
RRIM (1986) RRIM Planting Recommendations 1986-88. URL: http://rios. lgm.gov.my/cms. Accessed on 5th July 2011.
RRIM (1989) RRIM Planting Recommendations 1989-91. URL: http://rios. lgm.gov.my/cms. Accessed on 5th July 2011.
RRIM (1992) RRIM Planting Recommendations 1992-94. URL: http://rios. lgm.gov.my/cms. Accessed on 5th July 2011.
RRIM (1994) Planting materials used in Peninsular Malaysia, 1989-1992. In: Planters' Bulletin of The Rubber Research Institute of Malaysia. pp.3-11.
RRIM (1995) RRIM Planting Recommendations 1995-97. URL: http://rios.lgm.gov.my/cms. Accessed on 5th July 2011.
Shamsul Bahri A. R, Ong C.W, Jamilah M.S and Ariffin M.M (2013) Transmission electron microscopy (TEM) study on rubber particles in laticifers of native *Hevea* species. *Malaysian Journal of Microscopy*. Vol. 9 pg. 140-144.
Shigematsu A, Mizoue N, Kajisa,T and Yoshida S (2010). Importance of rubberwood in wood export of Malaysia and Thailand. *New Forests*, 41, 179-189.
Vischer W (1921) Results obtained with budded trees of *Hevea brasiliensis* on Pasir Waringin Estate, West-Java. *Archief Voor De Rubbercultuur*. Rubber Research Institute of Malaya. Vol 5, pp.43-45.
Vries O.D and Spoon W (1927) Rubber from budded trees. II. Investigations onlatex and rubber from some budded trees in the Cultuurtuin and their mother trees. *Archief Voor De Rubbercultuur*. Rubber Research Institute of Malaya. Vol.11, pp.146-149.
Webster C.C and Baulkwill W.J (1989) *Rubber*. Longman Scientific & Technical. UK.
Wititsuwannakul R, Pasitkul P, Kanokwiroon K, Wititsuwannakul D (2008) A role for a *Hevea* latex lectin-like protein in mediating rubber particle aggregation and latex coagulation. *Phytochemistry* 69: 339-347.
Yoonram K, Takahashi S, Rattanapittayaporn A, Koyama T, Wititsuwannakul Dhirayos and Wititsuwannakul R (2008) cDNA, from Hevea brasiliensis latex, encoding 1-deoxy-D-xylulose-%-phosphate reductoisomerase. *Plant Science*, 175: 694-700.

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